CLIMATE CHANGE AND DEVELOPMENT

CONSULTATION ON KEY RESEARCHABLE ISSUES

SECTORAL ISSUES
SECTION 2.2. WATER RESOURCES
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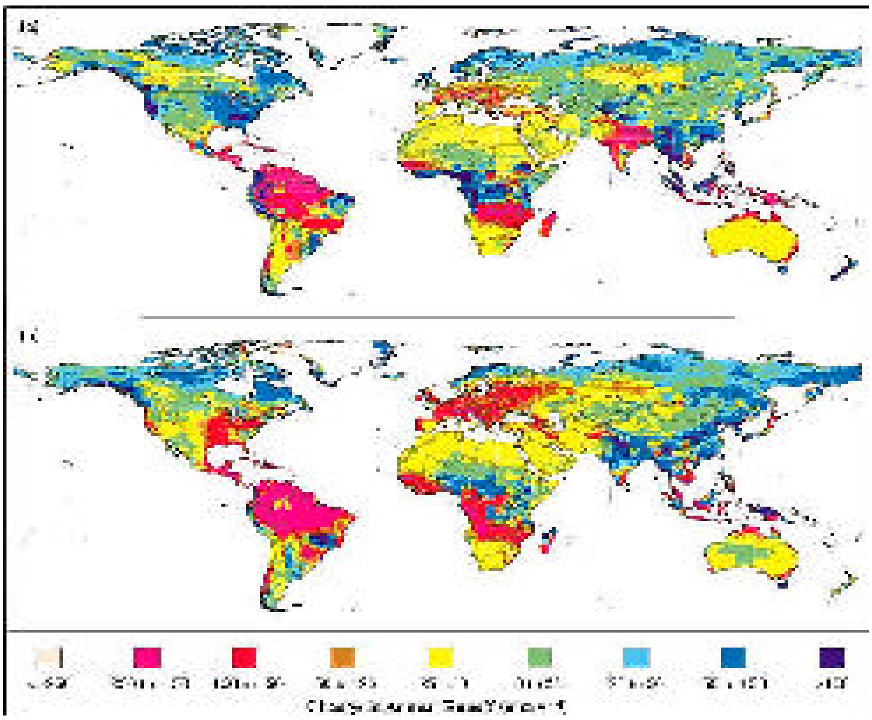
Climate Change and Water Resources

Climate change is expected to impact global water resources with present regional changes in the frequency and intensity of extreme weather events already being attributed to the changing climate. Moreover, evidence suggests that those countries already facing water stress (rather than just water scarcity), especially in Africa, will be particularly hard hit by changes in the hydrological cycle. Despite advances in regional modelling, predicting climate change impacts on water resources is exceedingly difficult, in part because water resources are not only shaped by the hydrological cycle but changes in population, technology, and the social, economic and political landscape. Rising population, urbanisation, pollution, changing agricultural sectors, and institutional and legislative conditions are only some of the diverse factors that ultimately determine future water demands. However, one fact remains -- that is for sure is that climate change will add *further* uncertainty to water resources management. This section will briefly describe some of the predicted climate change impacts on water resources and the need for climate change to be included in water resource planning. Furthermore, the section will explore how climate change adaptation can be included in water management, in particular, through Integrated Water Resources Management (IWRM).

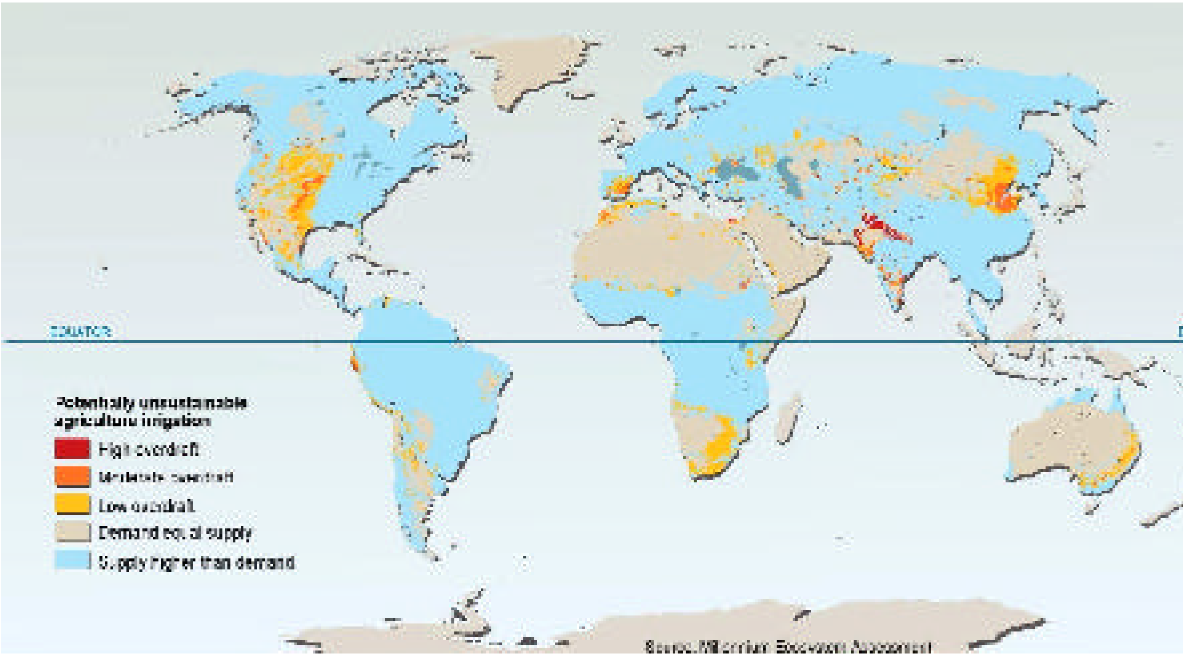
Figure 1: ***Change in average annual runoff by 2050 under HadCM2 ensemble mean (a) and HadCM3 (b)****



** Arnell, 1999b quoted in IPCC 2001 ch. 4. Figure 4-1*

The IPCC concludes that climate change will lead to an intensification of the hydrological cycles affecting both ground and surface water supply. Changes in the temperature, the frequency and intensity of precipitation and timing of runoff, as well as the intensity of floods and droughts will all have regional impacts on water supply and water quality. This, in turn, will affect domestic and industrial water supply, irrigation, hydropower, navigation, ecosystems, and tourism. The impact on irrigation is especially important since agriculture currently accounts for about 70 percent of water consumption worldwide, with the UN projecting a 50 to 100 percent increase in irrigation water by 2025.

Figure 2: Potentially Unsustainable Agriculture Irrigation



* Millennium Ecosystem Assessment, *Living Beyond Our Means*, Statement from the Board, 2005.

Climate change trends in temperature and precipitation and changing climate variability will have both first- and second-order impacts on water resources. For instance, changes in temperature, precipitation, water flow timing and glaciers will all directly impact water supply. When combined with social, economic, and political factors (such as rising populations, expanding and intensification of agricultural production, industrialisation, etc.) climate change may undermine development goals in many countries. For example, increased summer continental drying will cause more frequent and severe droughts, especially in continental interiors in Africa. Higher maximum temperatures and more hot days will lead to increased evapotranspiration. Higher surface temperatures can also reduce water quality. More intensive precipitation events are predicted over many northern-hemisphere and mid-to-high latitude areas which will cause more frequent and severe flooding. And accelerated glacier retreat and shifts in streamflow timing could lead to reduced downstream flow which will have widespread impacts on riverine ecosystems and irrigation, especially in some of the most intensive agricultural regions.

As with most climate change impacts, the effects of changes in water resources will be felt differentially, even within communities. Those depending most on water and those with the lowest abilities to invest or otherwise act to secure water will suffer first and hardest. This inevitably means that poor people and the their livelihoods will be impacted more.

Adaptation within the Water Sector

At present, there are no water management options that are uniquely suited to adaptation to climate change that "would be measurably different to those already employed for coping with contemporary climate variability" (Kabat, *et al*., p32). Adaptation to climate change will call upon existing strategies in water management; fortunately, there are a wide range of tools and strategies available within the field, both structural and non-structural. This section cannot hope to describe all; however, these approaches can be summarised into two main streams: supply-side and demand-side management. Supply-side water management represents the traditional approach in water policy: trying to increase the supply and access to water through technology, operating rules and even institutional changes. On the other hand, demand-side management aims to improve the more efficient use of *existing* water resources. Such approaches include more efficient irrigation practices and changes in water rights and allocation. In general, demand-side adaptation is thought to be more environmentally sustainable and cost effective, especially for poorer countries lacking the finances for large-scale technological solutions. Furthermore, the literature suggests that demand-side measures are better for tackling the underlying problems of water scarcity. However, supply-side adaptation is still important, and represents the dominant policy approach in many countries (especially in the Middle East and North Africa region). Research into climate change adaptation policy draws upon both supply- and demand-side approaches.

The real additional concern that climate change introduces to the water sector is greater *uncertainty* for water managers. For the water community, climate change will "exaggerat[e] current water pressures in water management – adding to the debate on sound management strategies" (IPCC 2001, ch. 4, p221). Climate change science demonstrates that future water resources will not be the same as in the past – a fact long acknowledged in development research (Matalas, 1997; Fiering and Matalas, 1990; Rogers and Fiering, 1990; Gleick, 2000) but not implemented in policy and industry. As such, a precautionary and anticipatory approach in water management is proposed, as opposed to a more 'incremental' approach found in some water management policies. For instance, vulnerability analysis "is a standard feature of water resources planning, but does not explicitly take climate change into account, although a wide range of drought and flood scenarios are routinely considered"

(Stakhiv, p164). Many within the water research community believe that water resources management, especially the tools of Integrated Water Resources Management, can accommodate the further uncertainties that climate change will bring to the water sector. Indeed, "[f]inding ways to deal with greater uncertainty in water management can act as a catalyst for innovation" (Bergkamp, *et al*., p27).

It was hinted above that supply-side approaches still dominate water policy in many countries. Many Governments facing growing water scarcity appear stubbornly optimistic that future water needs can be met by changes in technology alone, despite growing evidence to the contrary. For example, Algeria is representative of many MENA countries by planning to build more than 50 new dams, 10 diversion canals and tap non-renewable fossil water from beneath the Sahara. Water policy in such countries relies almost exclusively on technological solutions to combat growing water scarcity, which are not only expensive, but may not prevent eventual water shortages. Many operating in the water research community, especially those advocating Integrated Water Resources Management (IWRM), are exploring innovative demand-side strategies for tackling growing water scarcity; however, a paradigm shift is needed in many governments' policy (Kabat, et al., 2002). Climate change science could help support this push for IWRM and reinforce ongoing reform in the water sector.

Integrated Water Resource Management and Climate Change Adaptation

Within the literature, Integrated Water Resource Management (IWRM) is recognised as the most promising approach to managing water resources, especially in a changing environment and with changing water demands (Kabat *et al*., 2002; IPCC, 2001). IWRM also offers a solid platform from which to base climate change adaptation policy within various water sectors. It should be noted, however, that despite the recognised merits of IWRM, in reality it has often proved difficult to implement on the ground.

IWRM "involves three major components: explicit consideration of all potential supply-side and demand-side actions, inclusion of all stakeholders in the decision process, and continual monitoring and review of the water resource situation" (IPCC 2001, ch. 4, p223). As explained in earlier chapters, tackling current vulnerabilities to climate variability and deficiencies in water management is the best starting point for climate change adaptation policy. For example, more research is needed to enhance the preparedness of water systems (i.e. regarding risk assessment, watershed management, and increasing water storage in cases of flood and drought) and climate change adaptation can target such areas for improvement. Furthermore, as advances are made in climate change models, greater dialogue is need among meteorologists, water managers, and climate change modellers to act on new knowledge and feedback into the climate change models (Kabat, *et al*., 2002). Tackling the current 'adaptation deficit' to water and adopting interdisciplinary and multi-faceted approaches such as IWRM will go along way to increasing the ability for communities and countries to adapt to future climate change (IPCC 2001; Kabat *et al*, 2002).

The biggest problem associated with IWRM is that this holistic management style can be extremely costly and time consuming, hindering its use in poorer countries and communities. Moreover, there is a decline in meteo-hydrological networks in many less developed countries and "even the most basic indicators [used for water management including river discharge, rainfall, and subsistence irrigation] are generally becoming more and more scarce" (Bergkamp, *et al*., p34). As such, climate change adaptation will require that these issues be addressed, and this may be one area where the climate change and water communities can reinforce each other.

Emerging priority research themes: Addressing policy and research needs for adaptation.

A simplistic relationship between vulnerability and poverty is often assumed and has been important in shaping development policy. However, Tyndall Centre research suggests that resource-dependent societies can develop resilient adaptation strategies. Further analysis is required on resource scarcity in critical regions to demonstrate the wider imperatives of adaptation action. Studies of water risk assessment at different scales, including trans-boundary and regional adaptation and mitigation, including strategic plans for the world's large basins, such as the Limpopo, Yangtze, and the Nile Basin, are a high priority.

Source: Katrina Brown and Neil Adger, Tyndall Centre

Climate Change and Small Municipal Water Resources in South Africa

Source: Pierre Mukheibir

Water scarcity is a problem in many parts of the Southern African Development Community (SADC) region. Poor distribution of water resources and pollution coupled with frequent droughts and floods has lead to direct hardship for many people, particularly the poor, since it has affected food security specifically for subsistence farmers.. Climate variability is expected to alter the present hydrological resources in Southern Africa and add pressure on the adaptability of future water resources. During the past 20 years, most of Africa has experienced extensive droughts, the last two (1986-88, 1991-92) being attributed to El Nino. If the occurrence of drought becomes more frequent, the impact on water resources, and consequently agriculture, would be significant

South Africa is a water-stressed country with an average annual rainfall of 500mm (60% of the world average). Only a narrow region along the south-eastern coastline receives good rainfall, while the greater part of the interior and western part of the country is arid or semi-arid. 65% of the country receives less than 500mm per year, which is usually regarded as the minimum for dryland farming; 21% of the country receives less than 200mm per year.

Based on the climate model projections, the most severe impacts are likely to occur along the western part of South Africa, where small towns and subsistence formers are most vulnerable. The available literature suggests that it would be prudent to account for climate change in water resource planning to meet the development objectives of South Africa.

Currently, climate change does not feature prominently as a real threat to the reduction of the existing available water resources, hence strategies have not been developed to adapt to the projected impacts. Current water management mechanisms and policies have been developed to ensure that the existing supply of water meets the growing demand. Some of the mechanisms may be appropriate to deal with the future shortage that will be brought about by climate variation, but robust long-term strategies are required to ensure the demand for water matches supply, even in times of reduced availability. In addressing future projected climate change impacts, some of the measures may need to be introduced sooner than originally planned.

Presently we can observe the systematic dewatering of groundwater aquifers through demand outstripping supply and the poor management of the water resources. The over utilisation of the available yields of the ground water under present drought conditions does not bode well for future resource management under frequent drought conditions.

Current strategies for dealing with drought related water shortages that lend themselves to sustainable implementation in the longer term under drier climatic conditions include:

a) Groundwater recharge
b) Rainwater harvesting
c) Block tariffs
d) Dual flush toilets
e) Grey water systems
f) Education programmes
g) Water resource management systems
h) Groundwater monitoring systems - telemetry
i) Leak repair programme
j) Water restrictions

However, some of these strategies are not currently implemented for various reasons.

The adaptive capacity of small towns and communities to climate variability, specifically drought, should be investigated. Recommendation for policies and planning for national and local water resource planning and management should be developed to ensure water security against the impacts of climate change.

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Framework for adaptations to climate change in the SADC water sector

Source: Chris Magadza

The Intergovernmental Panel on Climate Change Third Assessment (IPCC TAR) noted that Africa was the most vulnerable continent to climate change (IPCC 2001). The major contributing factor to this vulnerability was Africa's low adaptive capacity. One of the major climate related threats to sustainable development was the likely impacts of climate change on Africa's water resources and its consequential implications to food security, health, biodiversity, energy and industrial development...

It is now widely acknowledged that effective water resources management is multifaceted and dynamic. Its dynamism arises from changes and uncertainties associated with climate variability and climate change and dynamic configurations of stakeholders..

Water resources planning is centrally important in development. The success or failure of water resources management planning will have significant impacts in society and on goods and services that society derives from aquatic ecosystems. The complexity of water resources planning is further aggravated by the fact of constant change: change in social and economic conditions, changes in political institutions, changes in climate etc.

The planning process must also be explicit on objectives to be attained and deliverable outcomes. The objective is to satisfy perceived needs in society. A clear definition of the needs enables the examination of various options of satisfying those needs.

Access to water resources can be a politically as well as emotionally charged issue, which, in circumstances of water scarcity, can translate to social and political conflict. Such conflicts may not be apparent at the time of the planning exercise, but may develop as water stress becomes more acute.

In the assessment of current and future water needs, certain regions of southern Africa are already identifiable as water stress areas while the entire region will be a water stress region by 2050. The sources of this stress are rooted in demographic changes, climate variability and climate change.

Flooding is a necessary process in ecosystem functioning of wetlands, which provide ecological and economic services to human populations. Wetland ecosystems have evolved under the major driving force of repeated flooding. Their function in water quality management (silt and sediment trapping, pollutants removal) is now increasingly exploited all round the world...

However, problems arise when human needs conflict with natural wetlands ecosystem dynamics. The encroachment of human settlements in flood prone areas, combined with extensive landscape alteration as seen in the Save and upper Limpopo catchments predisposes human settlements to disastrous flooding.

The quantification of costs from natural disasters in Africa is hindered by poor documentation of property and human life costs associated with disaster events. In the developed world, such costs are often arrived at by insurance costs. However, the majority of human populations that are often victims of natural disasters, such as floods and drought, are victims because of their economic status.

Drought, in the context of present day southern and east southern African economy, has far reaching impacts on the sustainable development of the subcontinent. Drought affects the energy sector, food security, wild life management, health and industrial sectors. The number of drought incidences and affected communities in the region has increased. Thus, the expectation of drought occurrences should be part of an integrated water resource and financial management planning.

The human society is always adapting to its environment, as communities or individuals. Such spontaneous adaptation is termed autonomous adaptation, in contrast to planned adaptation. Autonomous adaptation is an incremental process where communities or individuals learn from past experiences and modify their behaviour to cope with environmental changes and challenges

In the case of planned adaptation the precautionary principle may be applied. Adaptive measures are crafted in a way that brings benefits to society even in the absence of the perceived impact.

The environmental planning process has a basic assumption of social and political normalcy, for it anticipates continuity and stability in social systems to conserve and enhance social capital. Climate change impacts are often Transboundary in their origins and effects so that integrated regional cooperation becomes an essential component of effective sustained management

Flooding

Flood management planning, and indeed any disaster management process, is multidisciplinary, requiring skills and information from many sectors of economic and social development. In the SADC area, this level of national and regional integration is still in its infancy, though the structural framework of its implementation already exists in the form of the various SADC sectoral committees.

Drought

Famine is the mismanagement of drought or any natural event that affects food production. Areas within the SADC region will increasingly become high-risk areas for food production, solely on grounds of chronic insufficient soil moisture. In such areas it is prudent to explore areas of competitive economic advantage to compensate for the water shortage by virtual water imports, i.e. food grown in areas better endowed with water resources. The period to make such explorations is now.

Area of research

- The primary area of research is the method of indigenising the climate change issue in Africa.

My choice for this subject is that scientific information and data pertaining to climate change in Africa can be easily provided, but the use of that information is a function of the ownership of the problem, not by convention attending civil servants, but by the land and resource users.

Integrated Assessment of Vulnerability to Climate Variability and Change on the Gambia River Basin

Source: Bubu Jallow, Department of Water Resources, Gambia

Member states (Guinea, Guinea-Bissau, Gambia and Senegal) of the Gambia River Basin Development Organization (GRBDO) are LDC Parties to the UNFCCC. Various tributaries that flow into the Main River Gambia serve this watershed. More than 75% of the water body is fresh water serving the member countries in various forms. Multimillion-dollar energy and natural resources management projects are being developed for implementation in the subregion. Reduction in rainfall, increase in population and inappropriate land use practices have caused increase in water demand, decrease in river flow and reduction in freshwater availability. More information can be obtained from the following references.

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There is growing concern in the UNFCCC negotiations and the IPCC process that there exist gaps in the information in developing countries on climate variability and change. This gap is caused by weakness in the scientific, technical and financial capacity of scientists and institutions to produce the information.

It is a priority to initiate, develop and implement a collaborative research program between institution(s) in developed country(ies) and OMVG states with the objective of developing and strengthening the capacity of the relevant scientists and institutions of the OMVG member states in the integrated assessment of the impacts of and adaptation to climate change on the watershed of the River Gambia.

The research program will determine the degree of vulnerability of the watershed of the Gambia River Basin and develop and strengthen the scientific and technical capacity of institutions and individual scientists of the OMVG member states. The program will also:

1. establish the institutional and other practical arrangements required for the implementation of the Project and for the enhancement of the future and sustainable collaboration in climate change and watershed management;
2. enhance the scientific and technical capacities of scientists in OMVG States to assess the impacts of climate change, and identify and design cost-effective adaptation response measures that will serve as input to the development of effective policies;
3. develop and strengthen networking of collaborating institutions and scientists; and
4. contribute to the success of the global assessment of the climate system

Adaptation measures will be identified and integrated into the national policies of the countries. The program will also enhance the comprehensiveness of the IPCC assessments by developing and expanding the information base on impacts, adaptation and vulnerability of the watershed of the Gambia River basin.

The initial emphasis of the collaborative research programme will be to engage relevant institutions within the identified countries in the gathering and analyses of data and information needed to assess the potential impacts of climate change on watershed of the River Gambia. Building on the results of these studies, the gaps in knowledge and analysis of impacts will be identified. Appropriate analytical tools and methodologies will be selected and utilized in the integrated assessment of impacts and adaptation to climate change on the national economy of the countries.

The research programme will be executed at the regional level by the Secretariat of the OMVG in Dakar, Senegal and implemented by ENDA in Dakar, Senegal and at the national level by a Civil Society representative on the National Climate Committee in the member states. The secretariat of the Climate Change Focal Point in each of the member states will be fully involved in the implementation of the research programme at the national level.

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